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Design and Implementation of Remote Object Sensor Using MSP430

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Abstract: **- Over 1.5 billion in the world the elders are suffering from challenges of some sort of memory loss. A very common discomfort is in forgetting where their valuable objects are located, at their residences, cars, offices, etc. Conventional electronic methods to help such people employ a radio signal to excite a beeper tag attached to the object being searched, so that the object is traced by tracking the audible beep. However for people who have auditory challenges and in environments where loud beeps are not encouraged, or at distances where audibility is low, a more sophisticated technology has to be employed, without significant increase in cost and complexity of operation. Considering specific challenges mentioned above the possibility of elderly user's inability to read, write, type, this paper presents a novel method of object location using sensor networks and a locator tag attached to objects in residential settings that can be used not only to track objects, their location and neighbourhood. The system employs a simple, affordable, low-power mobile sensor tag that can either respond on demand to queries originating from a locator or proactively keep informing sensors about its locality, in addition to the legacy alarm sounding method. The paper presents the method and performance of such a system as shown by experimental results.**

I. INTRODUCTION

Mild Cognitive Impairment (MCI) is a condition in which people face memory problems more often than that of the average person their age. Symptoms often include misplacing items, forgetting events or appointments, and having trouble thinking of desired words. These symptoms, may do not prevent them from carrying out normal activities but several studies[1] have indicated an increased risk for developing Alzheimer's disease in MCI subjects progressing up to 55% in 4.5 years[2]. Normal aging is also associated with age-related memory impairment (AMI) wherein it is found that episodic memory is especially impaired with normal aging[3].One phenomenon, known as "Senior Moments", is a memory deficit wherein an older adult does not have the ability to re-engage after an interruption and continues to focus on the particular interruption unlike that of a younger brain. This inability to multi-task often leads to forgetting locations of objects, half-done work, etc. The several simple battery operated electronic instruments have been sighted in prior art [4] that have attempted to assist subjects with such memory loss problems.

II. DESCRIPTION OF THE PRIOR ART

In the prior art locators were devised and utilized for the purpose of finding objects and notifying audio purpose further such notifications were also in text format developed for the fulfilment of countless objectives and requirements. Prior approaches to signalling of the type disclosed herein are described in U.S Pat No 4,101,873 to Anderson and 4,507,653 to Bayer.

Cox in U.S. Pat No 4,598,272 discloses electronic monitoring of a person while Zeuschner in U.S. pat. No 3,855,575 discloses remote monitoring through ultrasonic signals. The apparatus not only enables the monitoring person to monitor the whereabouts of the monitored person, pet or article, but also to locate the latter if he, she or it becomes separated from the monitoring person. It also enables the monitoring person to interrupt an abductor, to draw attention to him, to frighten or confuse him, and hopefully, to cause him to release the monitored person, pet or article.
In addition to these challenges, a wireless sensor based system may not have a well-defined coverage area because propagation characteristics are dynamic and uncertain. Small changes in position or direction may result in drastic differences in the signal strength or quality of the communication link. These effects may get magnified with moving objects.

In one method, a remote control is used by the subject to press a button that is uniquely bound to a specific item of interest. An electronic tag is physically attached to the item of interest, which picks up a signal from the remote control and starts beeping in response to the radio signal from the

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remote[5]. However, the binding between the object and the remote is not reprogrammable nor extensible to include more tagged devices. Another type of locating mechanism is found to have a radio wireless network wherein a node of such a network sends a signal and the recipient tag can send an acknowledgement to help find its location from the network administrator. These methods assume that the network nodes are in static positions and in most of them the respondent tag node is expected to be within the direct radio-range of the locator node.

The work presented in this paper focuses in particular on situations where a subject forgets where specific objects are located, including objects that are portable and vulnerable to being misplaced and forgotten. Further the proposed architecture includes method of notification and user interaction developed to facilitate people with difficulty in hearing, colour blindness, and illiteracy.

As compared to a single point and direct radio range based measurements, the method employed allows for the locating the tag node even beyond direct radio range of the locator as well as obtain the object's position from the tag response which also contains information about its relative proximity with its neighbouring nodes in a sensor network. Thus the proposed method yields multiple measurements of which several reference node locations which can be used to improve accuracy and reduce error in locating the object. This is especially helpful in situations where audio beeps are not enough or cannot be employed and in cases where multiple objects have to be detected with one detector.

In view of such challenges inherent in the prior art, the present invention provides an improved remote object locator. The present invention relates to a remote object locator using with a radio wireless sensor networkr wherein a locator node of such a network sends a signal to the tag node through one or more hops on the sensor network and the corresponded tag node in response tries to identify location of neighbouring static nodes, weighted by their proximity to the tag, and send back the information. The locator node then computes and reports the proximity and location information prioritized in order of closest to farthest neighbours of the tag node, which helps in locating the node. In addition, if the audible notification is enabled, the tag can also generate audible beeps which help the user further track down the tag upon reaching its locality. These methods assume that the static node know their locations and the detector and tag nodes is within range of wireless network.

Advantages of present invention

1. Extended Range: The multiple hops through several nodes in network and many nodes help in finding and the locating of the object much farther direct radio range of the locator.
2. Redundancy: The presence of multiple routes in the sensor network helps to find and locate the object through alternative paths.
3. It employs static nodes only for neighbour nodes which can a located in each distinct location. The tag nodes can be mobile in network.
4. The information exchange is encrypted so that the transaction cannot be activated/tapped by unauthorized devices.
5. Literacy – iconic interface with images of objects
6. Colour blindness – alternate colour palette
7. Multi-tagging with common locator
8. Multi-locator for same tag
9. search group of tags based objects needed for a particular work
10. Schedule based task reminders along location information of objects required for task.

Therefore the present invention substantially enhances the capabilities and mechanism of remote object locator systems, especially for geriatric care.

III. SUMMARY OF THE INVENTION

Terms [7]

Device: Any entity containing an implementation of the IEEE 802.15.4 medium access control (MAC) and physical interface to the wireless medium. A device may be a reduced-function device (RFD) or a full function device (FFD).

Full-function device (FFD): A device capable of operating as a coordinator.

Coordinator: A full-function device (FFD) capable of relaying messages. If a coordinator is the principal controller of a personal area network (PAN), it is called the PAN coordinator.

***Personal area network (PAN) coordinator*:** A coordinator that is the principal controller of a PAN. An IEEE 802.15.4 network has exactly one PAN coordinator.

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Reduced-function device (RFD): A device that is not capable of operating as a coordinator.

Two different device types can participate in an IEEE 802.15.4 network; a full-function device (FFD) and a reduced function device (RFD). The FFD can operate in three modes serving as a personal area network (PAN) coordinator, a coordinator, or a device. An FFD can talk to RFDs or other FFDs, while an RFD can talk only to an FFD. An RFD is intended for applications that are extremely simple, such as a light switch or a passive infrared sensor; they do not have the need to send large amounts of data and may only associate with a single FFD at a time. Consequently, the RFD can be implemented using minimal resources and memory capacity.

A system conforming to this standard consists of several components. The most basic is the device. A device may be an RFD or an FFD. Two or more devices within a POS communicating on the same physical channel constitute a WPAN. However, this WPAN shall include at least one FFD, operating as the PAN coordinator. An IEEE 802.15.4 network is part of the WPAN family of standards although the coverage of the network may extend beyond the Personal operating space (POS), which typically defines the WPAN.

IV PROPOSED APPARATUS

1. Locator Node (L N): This Locator node is used as reduced function device (RFD/End device).This node is considered to be in mobile. The device (cell phone) is used to send the request to locate the object to the tag node and get the information of located object from tag node .

2. Tag Node (T N): This tag node is designed from the apcog to transmit (Broadcast) and receive (unicast) the signals to and from the neighbouring nodes with respect to the location of the objects. This Tag node is used as reduced function device (RFD/End device). This node is considered to be in static.

3. Neighbour Nodes (N N): This Neighbour node is used as reduced function device (RFD/End device) and also as (FFD/Coordinator). This node is considered to be in static. This Neighbour nodes is used to receive the message from tag node and transmit the information in the message format to the tag node.

4. Router Nodes (R N): This Router node is used as Full functioned device (FFD/Coordinator). This Router nodes is used when the direct search method fails i.e. when Locator node send the message to the tag node and the tag node fails to receive that message then Router must send the message to the slave coordinator's (unicast) i.e. "to find the Tag in the network" using "bping".

5. Slave Nodes (S.N): This **Slave** node is used as reduced function device (RFD/End device) and also as (FFD/Coordinator).The slave nodes are used as the intermediate nodes between the router to transfer the message of the locator node from router to tag node.

V PROPOSED METHOD

The proposed system employs a two step method to identify a target object. In the first step it checks if the target is locatable directly within its radio range. If the first step does not find the object tag, it then moves to next step wherein it employs the sensor network nodes for routing its query and locating the object tag indirectly through different nodes and routes in the sensor network.

These two steps are explained below as separate methods to detect the location of the object.

- ✓ Direct Search Method: This method is used when the Locator node and tag node are within direct reach and able to communicate directly.
- ✓ Indirect Search Method: This method is used when the Locator node and tag node are not within direct reach and not able to communicate directly but able to communicate indirectly through router nodes.

1. Direct Search Method.

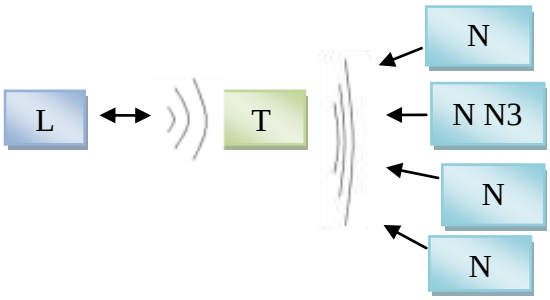

Figure 1: Direct search method

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VI. DESCRIPTION OF THE PREFFERED EMBODIMENT

Direct Search Method.

1) Figure1 explains the Locator device (end device) sends a message that contains the node id to be located with "bping" command to the tag device (end device).

a) create a message frame that contains the address of the locator node and the address of the tag node for the message to be sent, bping command, and node id of the object to be located, and no of hops.
b) Send the message frame (in unicast mode of 802.15.4 standard) addressed to the tag node.
c) If the tag device is within direct radio range of the locator, it receives the message and interprets the bping command.
d) Accordingly, the tag node initiates a message in broadcast mode of 802.15.4 standard to its surrounding neighbour nodes, seeking their response.
e) Every neighbouring node within the direct radio range of the tag will receive and interpret the broad cast message and however, only a response is evoked only from static nodes (information if a node is static and if so its location, are pre-defined on respective nodes in the sensor network).
f) In the response, the static neighbour nodes measure the signal strength they received from the tag node and send the strength information back in a message including additional information about their own locations. This message is sent as a reply in unicast mode of 802.15.4 standard to the tag device.
g) Upon receiving the response from each neighbour node, the tag extracts the forward and reverse path signal strength information and calculates their average.
h) For each neighbour, the location information is stored with descending order their corresponding average signal strength information.
i) The sorted list of neighbour information is sent back to the locator node from the tag node as a response to the locator's query.
j) The Locator device upon getting the reply message extracts and displays the location information of neighbours of the tag node and display the same in a sorted order of proximity (as indicated by signal strength) to tag node. One should note that signal strength serves as a good and simple approximation to physical proximity, while they may not be exactly same depending upon their path of radio propagation.
k) Using this information the user can reach near the tag node location. The tag can also generate audio beep, which helps the user zero-in on its location, upon reaching its proximity.

VII. INDIRECT SEARCH METHOD

Figure 3 explains the different scenarios in the indirect search method there is a Locator node and the tag node in between the locator node and the target node there can be many router nodes which acts as an intermediate between the locater node and the tag node. From the tag node to all the neighbour nodes the communication will be in the form of broadcast and the reply from the neighbour nodes to the tag nodes will be in the form of unicast.
During indirect search method we face three scenarios.

1. Non access through the network (through route 1).

When the Locator node wants to transmit a message to the Tag node and the tag node is not with in the direct reach and hence the router nodes will carry the message from the locator node and deliver to the tag node. If in case the router node fails to reach the tag node then the message carried with the router will be dropped (evaporated).

2. Indirect access of the network through the single hop (through route 2).

When the Locator node wants to transmit a message to the Tag node and the tag node is not with in the direct reach and hence the router nodes will carry the message from the locator node and deliver to the tag node. If in case the router node delivers the message to the node address to which the locator node wants to send to the tag node i.e. on the Router device side If the message contains that any of the replied slave coordinator's have found the Tag device with highest signal strength then the process of single hop is terminated. This process is called as the indirect access of the network through the single hop.

3. Indirect access of the network through the multiple hops (through route 3).

When the Locator node wants to transmit a message to the Tag node and the tag node is not within the direct reach and hence the router nodes will carry the message from the locator node and deliver to the tag node. If in case the router node fails to deliver the message to the node address to which the locator node wants to send to the tag node .Then the

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message transmission through the single hop failed hence we have to transmit a message from the router to the router so that the message reaches the tag node. Hence this process is called as the indirect access of the network through the multiple hop.

10) If direct search method fails then the Locator must send the message frame (in unicast mode of 802.15.4 standard) addressed to the tag node, to the Router node (i.e. through route1) to communicate with the coordinators (slave devices) in its surrounding for the first hop.

11) Then the Router must send the message frame (in broadcast mode of 802.15.4 standard) to the slave coordinator's i.e. "to find the Tag in the network" using "bping"

12) The slave coordinators will send a message frame (in unicast mode of 802.15.4 standard) reply to the Router device.

13)On the Router device side If the message contains that any of the replied slave coordinator's have found the Tag device with highest signal strength's then the process of first hop is terminated .

14) If not then the Locator must send the message frame (in unicast mode of 802.15.4 standard) addressed to the tag node, to the Router node. (i.e. through route 2) i.e the second hop starts.

15)The Router device send the message frame (in broadcast mode of 802.15.4 standard) to all the Neighbour nodes to "find the Tag "

16) The Neighbour node devices will collect the information
a) Not found the tag device.
b) Found the tag device.
and send this message frame (in unicast mode of 802.15.4 standard)to Router device .

17) The Router will extract the information of found information with highest LQI and then decide the position of the Tag device.

18)If not found then the second hop is terminated and the third hop starts, then the Locator must send the message frame (in unicast mode of 802.15.4 standard) addressed to the tag node, to the Router node(i.e. through route 3). i.e the third hop starts.

15)The Router device send the message frame (in broadcast mode of 802.15.4 standard) to all the Neighbour nodes to "find the Tag "

16) The Neighbour node devices will collect the information
a) Not found the tag device.
b) Found the tag device.
and send this message frame (in unicast mode of 802.15.4 standard)to Router device .

17) The Router will extract the information of found information with highest LQI and then decide the position of the Tag device.

Then direct search method continues.

1. Direct Search Method Flow.

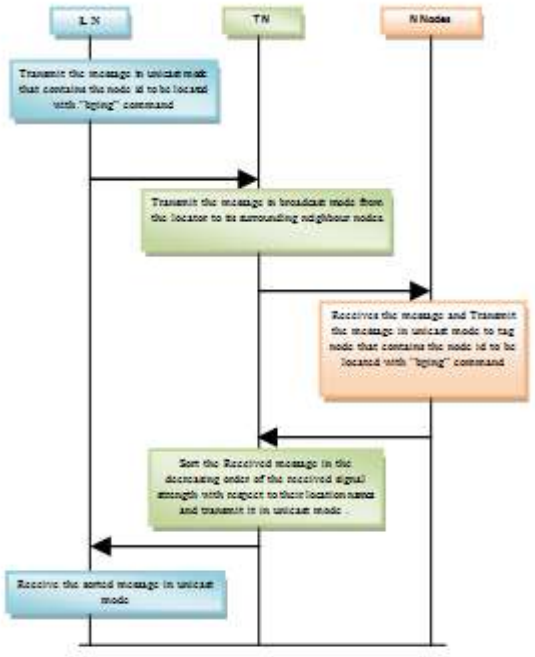

Figure 2: Flow of Direct search method

2. Indirect Search Method.

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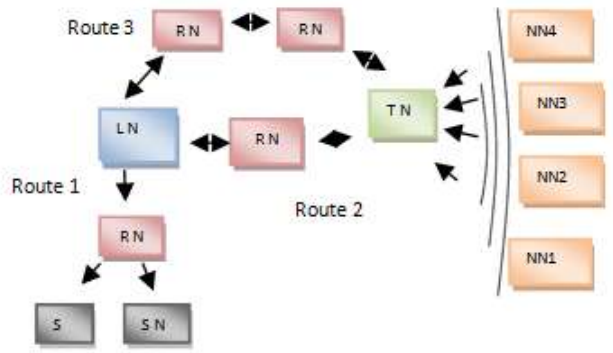

Figure 3: Indirect search method

VIII RESULTS

The detection of the location of the object are notified in three modes. The notification will be in the form of beep, or display or both beep and display. The user can reach the object due to beep sound, or display of location of the object on the device as a pop up message, or by both display and beep.

IX NOTIFICATION IN BEEP

The devices in our proposed system are tested by connecting a USB stick (Coordinator in our case) to the PC screen which has real time configurable parameters that can be accessed by the user only in real time.

For Ex: When a button is clicked on the MC1322x sensor/Network end device node interfaced with the user screen(Laptop), messages are being passed from the coordinator connected wirelessly to the MC1322x sensor/Network end device node interfaced with the APCOG Sensor Board. The sensor reports the Link Quality Indicator data back to the user (PC) through coordinator whenever there is a decrease or increase in the signal strength.

The Locator device upon getting the reply message extracts and displays the location information of neighbours of the tag node and display the same in a sorted order of proximity (as indicated by signal strength) to tag node.

Using this information the user can reach near the tag node location. The tag will generate audio beep, which helps the user to find its location, upon reaching its proximity. The wireless sound notification system can significantly improve the quality of life for many visually impaired people.

X NOTIFICATION IN DISPLAY

The Locator device upon getting the reply message extracts and displays the location information of neighbours of the tag node and display the same in a sorted order of proximity (as indicated by signal strength) to tag node.
Using this information the user can reach near the tag node location.

Imagine that mobile node (MN1) needs to be located. You can see MN1 is in the vicinity (within its transmission radius) of three static nodes, so it is able to estimate its position using a multilateration technique, which can be based on range measurements taken using received signal strength indicator (RSSI) or by measuring the angle of arrival (AOA). AOA implies the use of multiple antennas, so that's why using range measurement based on RSSI is simpler and lower cost.
For IEEE 802.15.4-based position monitoring systems it is important to have enough coverage for device triangulation.

$$n_i = -\left[\frac{RSSI_i - A}{10\log_{10} d_i}\right]$$

Where:
n: Signal propagation constant or exponent
d: Distance from sender
A: Received signal strength at 1 meter distance
The value A is obtained in a no-obstacle one-meter distance signal strength measurement from the SNs.

XI NOTIFICATION IN BOTH BEEP AND DISPLAY

The Locator device upon getting the reply message extracts and displays the location information of neighbours of the tag node and display the same in a sorted order of proximity (as indicated by signal strength) to tag node. Using this information the user can reach near the tag node location. The tag will generate audio beep, which helps the user to find its location, upon reaching its proximity
The user can reach the object due to beep sound and display of the information of the located object.

Merits

1. Non complex: Easy to use, user-friendly.

2. Low cost: At present whatever the product on locator is available in the market compare to that this remote object locator is ten times cheaper to that of the product available in the market.
3. Low power consumption: Battery life of 1 unit support for 2 years
4. Less delay: Minimum time required to respond to an event.
5. More Robust: The application is built powerfully.
6. Form Factor (Small size): The object locator should fit a standard remote control.
7:Network range: 100 mts (Nominal) up to 150 mts Max.
8. Speed: Transfer rate up to 20 micro second.
9: Supports large network orders (<= 65k nodes)

Applications

1. To locate the object using sticker nodes.
2. This concept is used in detecting the location of the mentally disabled in the mentally disabled hospitals
3. To detect the location of the Prisoners in the Prison.
4. To detect the location of the child. Remotely within the network.

XII CONCLUSION

In this paper, a novel smart system is proposed to locate the object remotely within the network. apcog offers low-cost, robust, complete hardware and software platforms for the 802.15.4 marketplace, enabling system providers to develop compelling and competitive solutions, such as the one presented in this article. An IEEE 802.15.4, a very recent communication protocol is suitably applied for this system. In this project, a cost-effective IEEE 802.15.4 Based Remote Object locator was built. A prototype system was constructed with a low cost and high performance microcontroller which is being used to develop enabling technologies for a Personal Aid for Mobility and Monitoring. Regarding ZigBee protocol, the flexibility and robustness of the network protocol was investigated. The remote object locator could be further extended to translate IR signals from other remote controls to wireless media and thus enable wirelessly to locate several objects. Remote object locator can be placed on wheel chair and also used in home automation purpose. In short, apcog enabled location monitoring using IEEE 802.15.4 technology can help make lives safer and healthier. Products such as the MC13224V allow designers to implement low-power, cost-effective ZigBee mesh networks that can provide effective location monitoring for a variety of environments.

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